Specification

1. Title of Invention

Piston Pin of Internal Combustion Engine

2. Claim

A piston pin of the internal combustion engine, characterized in that the central area where a smaller end of a connecting rod is engaged is formed in a cylinder; both ends engaged with pin bosses of a piston so as to oscillate as needed are formed in a taper shape that expands the diameter toward the two ends and split into members that can be engaged with each other in a proper location.

3. Detailed Description of the Invention

Field of Industrial Application

This invention pertains to an improved piston pin that connects a piston of the internal combustion engine and a smaller end of a connecting rod.

Prior Art

A piston of the internal combustion engine is connected to a smaller end of a connecting rod so as to be oscillatable via a cylindrical piston pin. The piston pin is usually kept at a non-fixed state in relation to the piston as a fully floating type or a semi-floating type.

Fig.6 illustrates prior art fully floating piston connecting structure. A pair of pin bosses 22 is formed inside a piston 21 made of an aluminum alloy. Both ends of a piston pin 24 are engaged with through holes 23 of the pin bosses 22 so as to be oscillatable. The loosening is prevented with snap rings 25. Similarly, a smaller end 26a of a connecting rod 26 is also engaged with a piston pin 24 so as to be oscillatable.

In this case, as shown in the drawing, the piston pin 24 is in the form of a simple cylinder. In order to improve the bending stiffness of the piston 24, a reinforcing rib is formed inside a hollow part, which is exemplified in Japanese unexamined utility models No.60-116461 and No.59-168061.

Problem to Be Solved by the Invention

At the constitution as described above, 1/2 of combustion pressure F individually acts on the two ends of the piston pin 24, more specifically areas that are engaged with the pin bosses 22. To support the force, it is necessary to take length L of each engaging part at a certain level of a large size. In other words, when length L of the engaging part is reduced, the surface pressure excessively increases so as to cause a burning or breakage of the pin bosses 22.

Thus, there is a limitation in reduction of the total length of the piston pin 24 and in minimization of the pin bosses 22. As a result, the reduction in the weight of the whole

reciprocating motion part that is comprised of the piston 21 and the piston 24 cannot be sufficiently achieved.

Measures for Solving the Problem

Accordingly, the present invention is produced to reduce the surface pressure by a combustion pressure by having a taper shape on the engaging part of a piston pin with pin bosses. More specifically, the piston pin of the internal combustion engine by the invention is characterized in that the central area where a smaller end of a connecting rod is engaged is formed in a cylinder, and that both ends engaged with pin bosses of a piston so as to oscillate as needed are formed in a taper shape that expands the diameter toward the two ends and split into members that can be engaged with each other in a proper location.

Effect

At the above constitution, when the diameter of the central area where the smaller end of the connector rod is engaged is predetermined as similarly to as in prior art piston pin, if the length of the engaging part to the pin bosses is equivalent to that as in prior art piston pin, the area to receive a pressure increases because of the taper shape given to the end of the piston pin to reduce the surface pressure by the increased area. In other words, if the allowable surface pressure is equivalent to that as in prior art piston pin, the length of the engaging part can be minimized.

Working Example(s)

A working example of the invention is described hereinbelow based on the drawings.

Fig.1 illustrates a structure in that a piston 2 and a smaller end 3a of a connecting rod 3 are connected to each other using a piston pin 1 of the invention.

As for the piston pin 1, a central area 4 where the smaller end 3a of the connecting rod 3 is engaged is in a cylindrical form. Two ends 5 and 6 that engage with pin bosses 2a so as to be oscillatable are formed so as to be a taper shape that extends the diameter toward the ends. A through hole 7 for mounting the piston pin formed on the pin bosses 2a is also formed in a taper shape that corresponds to the taper surfaces of the ends 5 and 6 of the piston pin. Length L_2 of the outer shape of the pair of the pin bosses 2a is predetermined so as to be extremely short in comparison with the diameter of a crown 2b of a piston 2. Total length L_1 of the piston pin 1 is also short.

In order to make it possible to be incorporated into the piston 2, the piston pin 1 is divided into two components: a pin body 1A that consists of the cylindrical central area 4 and the taper-shaped end 5 on one side; a cylindrical pin end member 1B that forms the taper-shaped end 5 on the other side. The cylindrical pin end member 1B is press-fit in a shaft 8 that is formed on the tip of the pin body 1A to be integral with each other. Snap rings 9 are attached on both ends of the through hole 7 so as to prevent the falling of each member at the assembly of the piston pin 1.

In order to reduce the weight of the piston pin 1, the pin body 1A is formed in a cylindrical shape having a hollow part 10 whereas a hollow part 11 is also formed on the side of the pin end member 1B.

The effect as in the structure is described next.

Fig.2 illustrates the direction and intensity of a force when a combustion pressure acts on a taper-shaped engaging area as described above. ½ of combustion pressure F acts on each engaging area along the axial line of the cylinder. In this regard, when the inclination of the taper of the engaging areas is defined as θ, the force that vertically acts on the contact surface of both engaging areas becomes $(F/2)\cdot\cos\theta$, which is smaller than $F/2$.

On the other hand, if the maximum diameter is defined as D_1, the minimum diameter as D_2, and if the length of the engaging areas as L_b, projection area S_1 of the engaging areas seen from the force acting direction is indicated by the following formula:

$$S_1 = (D_1 + D_2) \times L_b / 2$$

Surface pressure P1 is indicated by the following formula:

$$P_1 = \frac{(F/2)\cdot\cos\theta}{S_1} = \frac{F\cos\theta}{(D_1 + D_2)L_b}$$

Minimum diameter D_2 is determined from the surface pressure of the smaller end 3a of the connecting rod. As minimum diameter D_2 is predetermined so as to be equivalent to the diameter of prior art cylindrical piston pin, projection area S_2 of the engaging areas at prior art piston pin (see Fig.6) is indicated by the following formula:

$$S_2 = D_2 \times L_a$$

Surface pressure P_2 is indicated by the following formula:

$$P_2 = \frac{F/2}{S_2} = \frac{F}{2 D_2 L_a}$$

Then, if the allowable surface pressure is equivalent to that as in prior art piston pin, P_1 is equivalent to P_2. Accordingly, the following formula is obtained:

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$$\frac{F\cos\theta}{(D_1 + D_2)L_b} = \frac{F}{2 D_2 L_a}$$

Thus, the following relationship is obtained:

$$L_b = \frac{2 D_2 \cos\theta}{D_1 + D_2} \cdot L_a$$

In this case, the following relations of each element is obtained:

$\cos\theta < 1$ and $2D_2 < D_1 + D_2$

Because of this, the following relation is constantly established:

$L_b < L_a$

In other words, while the surface pressure between the piston pin 1 and the pin bosses 2a is retained as similarly to as in prior art piston pin, the length of the engaging areas of these components is minimized. The diameter of the pin bosses 2a is thus minimized, thereby reducing the total weight.

As shown in Fig.2, a force of $(F/2)\cdot\cos\theta\cdot\cos\theta$ acts in the shaft direction of the piston pin 1, which is relatively small to be able to sufficiently control by the tensile strength of the piston pin 1.

Fig.4 and Fig.5 illustrate the other working example of the invention.

At the working example, a shaft unit 8 on the tip of a pin body 1A is engaged with a pin end member 1B in a penetrating fashion. A c-shaped snap ring 12 is also mounted on the tip to prevent the loosening of the pin end member 1B.

With the structure, a press-fitting operation for the pin end member 1B is not required. Thereby, the operability of the assembly improves. Furthermore, no snap rings are required on the ends of a through hole 7.

Advantageous Effect of the Invention

As is clear in the above description, according to the piston pin for the internal combustion engine of the invention, because of the taper-shaped ends engaged with the pin bosses, the total length of the piston pin is minimized while the surface pressure to the combustion pressure is retained at a predetermined allowable surface pressure to make it possible to minimize the size of the pin bosses. Thereby, minimization in the weight of a reciprocating motion area that contains the piston and the piston pin is achieved.

4. Brief Description of the Drawings

Fig.1 is a cross-sectional view illustrating a whole piston that uses a piston pin of the invention. Fig.2 illustrates a vector of a force that acts on the piston pin. Fig.3 illustrates a taper-shaped end. Fig.4 is a cross-sectional view illustrating a whole piston as in the other working example of the invention. Fig.5 is a side view illustrating the main components of the piston. Fig.6 is a cross-sectional view illustrating a whole piston that uses prior art piston pin.

1...Piston pin

1A...Whole pin

1B...Pin end member

2a...Pin bosses

4...Central area

5 and 6...Ends